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(54) **A device for detecting the presence of an object**

(57) A device for detecting the presence of an object. The device includes an optical fibre (7) which may be buried under a railway line 4 to be monitored, a coherent light pulse generator which injects a pulse into an end of the fibre, and a receiver which receives the pulse backscattered by the fibre. The fibre 17 has a corrugated sheath 16 (16) which intensifies the effect of local distortion on the fibre, thereby allowing measurement and detection of the position of the distortion of the fibre.

FIG. 3

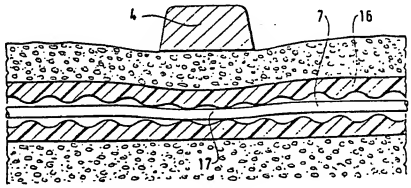

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FIG.1

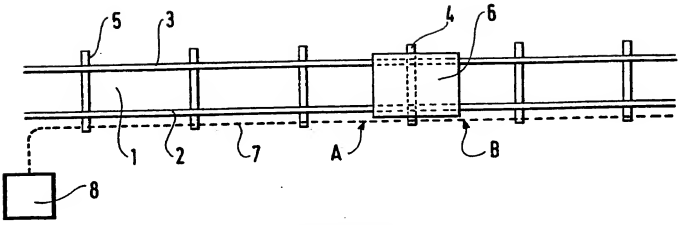

FIG.2

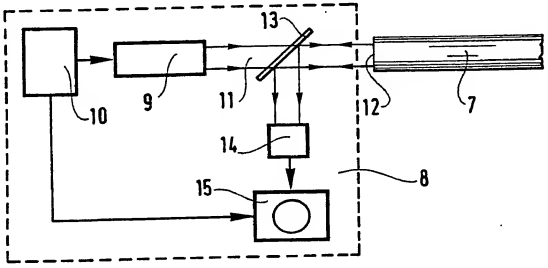

FIG.3

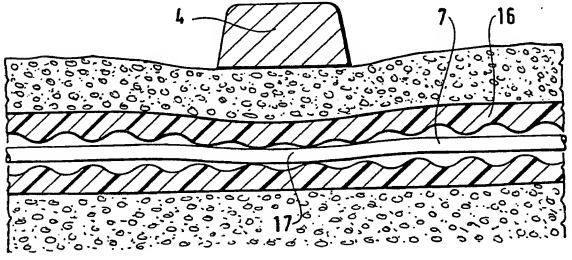

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FIG.4

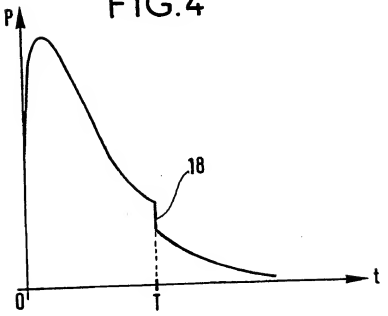
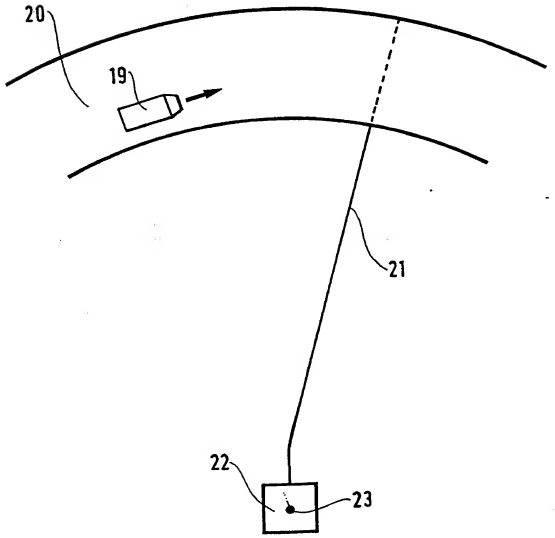


FIG.5



SPECIFICATION

A device for detecting the presence of an object

The present invention relates to a device for detecting the presence of an object, and it is particularly, but not exclusively adapted to detecting the position of an object along a line, e.g. a train along a railway.

BACKGROUND TO THE INVENTION

British patent n° 1 497 995 describes a system for detecting the presence of an intruder around a perimeter which is being guarded. The system relies on the fact that imperfections in an optical fibre return echos of light pulses being transmitted by the fibre. The positions of the imperfections can be deduced from their echos and echo-producing imperfections can be induced by a kink or bend in the fibre. Thus in the system described optical fibres are laid around the perimeter and light pulses are transmitted therein. When trodden on by an intruder the fibres return echos from the place where they are being distorted.

Unfortunately a usually desireable characteristic of optical fibres, namely their substantially interference – free transmission, is a hindrance in this particular application. The present invention therefore aims at producing a device for detecting the presence of an object, in which the sensitivity of an optical fibre to local distortion caused by the object to be detected is increased with respect to that of conventional optical fibres.

THE INVENTION

The present invention provides a device for detecting the presence of an object, the device, including:

– a light generator disposed at a reference point and capable of emitting an outgoing pulse;

– an optical fibre disposed along a line in such a way that the weight of the object to be detected when situated near a portion of the fibre causes elastic distortion of the portion, one end of the fibre being placed so as to receive the outgoing pulse from the light generator, the distortion generating a return pulse by partial reflection; and

– a photoelectric receiver disposed near said one end to receive the return pulse; wherein the optical fibre is surrounded by a covering which has a rough inner surface, said distortion being exerted by the rough portions of the inner surface on the outer surface of said portion of the fibre.

THE DRAWINGS

Two devices embodying the present invention are described hereinbelow by way of example with reference to the accompanying drawings in which:

– *figure 1* shows schematically a first device embodying the invention;

– *figure 2* is a more detailed schematic illustration of an emitter-detector system which forms a part of the device illustrated in figure 1;

– *figure 3* shows a partial cross-section of the device illustrated in figure 1;

– *figure 4* is a graph of the signal which appears on a measuring device forming a part of the system illustrated in figure 2; and

– *figure 5* illustrates schematically a second device embodying the invention.

DESCRIPTION

Figure 1 shows a railway track 1 which comprises two rails 2 and 3 fixed on sleepers such as 4 and 5 which rest on ballast. A vehicle 6, e.g. a locomotive, travels along the track 1. An optical fibre 7 is disposed along the track 1. Preferably, the optical fibre 7 passes under the sleepers of the track, buried at a shallow depth in the ballast.

One end of the fibre 7 is connected to a light transmitter-receiver system 8 placed at a reference point, e.g. in a station.

The transmitter-receiver system 8 shown schematically in figure 2 includes a laser transmitter 9 such as an injection laser fed by a pulse generator 10. The light beam 11 emitted by the transmitter 9 is trained on the plane end surface 12 of the fibre 7 through a partially reflecting plate 13 inclined at 45° to the axis of the beam 11. A photoelectric receiver 14, constituted for example by a silicon diode, is disposed to receive light coming from the fibre 7 and reflected by the plate 13. Electric pulses emitted by the receiver 14 are directed towards oscilloscope 15 whose scanning is synchronized with the frequency of the pulse generator 10.

Figure 3 shows a cross-section of the device illustrated in figure 1, along a plane AB perpendicular to the plane of figure 1 and parallel to the direction of the track 1. The plane cuts through one end of the sleeper 4 which is situated under the vehicle 6. The plane also cuts through the ballast which supports the sleeper, so as to show the buried optical fibre 7. As shown in figure 3, the fibre 7 is surrounded by a covering 16 of plastics material. The inner surface of the covering 16 is rough and has, for example, corrugations as shown in the figure.

The device described hereinabove operates as follows.

The weight of the vehicle causes a small temporary depression of the ballast, in particular under the sleeper 4 which carries the weight of the vehicle 6. The deformation of the ballast, shown in an exaggerated illustration in figure 3, is transmitted to the covering 16 which sags in turn and causes elastic radial compression of the fibre 7 on a longitudinal portion 17 situated immediately in the proximity of the point where the vehicle passes. By way of an example, the longitudinal profile of the inner surface of the covering 16 can have quasi-sinusoidal corrugations whose pitch is 2 millimetres and the covering can communicate temporary axial deformations of about 100 to 200 microns to the outer surface of the fibre. The plastics material which constitutes the covering must be sufficiently hard to be able to obtain such deformations, but also sufficently soft to remain elastic and not to break

under the effect of the passage of the vehicle. The optical fibre is of the type used in optical telecommunications and can be made of silica by the vapour phase depositing method, for example.

It is possible to detect the temporary deformation of the portion 17 of the fibre 7 by means of the transmitter-receiver system 8.

Indeed, the laser transmitter 9 injects recurrent outgoing light pulses into the fibre at a low rate. The fibre does not transmit all of the energy which it receives : each point of the fibre returns a small portion of the input light energy to the end surface 12; this proportion depending on the coefficient of attenuation of the fibre. Figure 4 shows the graph which appears on the screen of the oscilloscope 15 in response to an outgoing pulse emitted by the transmitter 9 and received on the receiver 14 after backscattering by the fibre 7.

The graph is plotted with two rectangular coordinate axes OP and Ot, P on the Y-axis representing the back scattered light power and t being time. It is seen that generally, the curve decreases exponentially as a function of time. An irregularity is observed on the curve, this irregularity is constituted by a return pulse 18 due to the local light attenuation caused by the temporary deformation of the portion 17 of the fibre.

The interval of time OT between the emission of the outgoing signal and the reception of the return signal, read directly on the graph of figure 4, is proportional to the distance measured along the fibre 7 between the reference point and the point where the vehicle is passing and therefore represents the position of the vehicle in relation to the reference point.

The amplitude of the return signal 18 and the duration thereof also allow the weight or the length of the vehicle to be estimated.

Figure 5 shows another embodiment of a device in accordance with the invention, said embodiment being particularly suitable for detecting a vehicle 19 such as a road vehicle driving along a road 20.

In this case, the device includes an optical fibre such as 21 a portion of which is disposed across the road 20, the fibre 21 being provided with a covering analogous to that described hereinabove. It is preferentially buried at a shallow depth in the ground, in particular where it crosses the road 20. One end of the fibre 21 reaches the input of a transmitter-receiver system 22 situated at a reference point 23 and analogous to that of the device shown in figure 2.

The operation of the device shown in figure 5, analogous to that of the device shown in figure 1, allows the passage of the vehicle at a point of the road to be detected without the vehicle driver being aware of the fact. Indeed, even in the case where the covering which surrounds the optical fibre is laid directly on the surface of the road, the covering will be practially invisible if it is made of a translucent plastics material and has a small radius.

The device shown in figure 5 can be applied in particular to detecting the passage of a military vehicle on a road, the device placed at the reference point then being suitably camouflaged.

More particularly, the device in accordance with the invention can be applied to detecting the presence of an object along a line. Since the optical fibre is disposed along the line, the possibly very light pressure exerted by the weight of the object at a point along the line makes it possible to determine the position of the object along the line.

The object can be a person and the device can be applied for example to determining the arrival of an intruder inside civilian or military installations. In this case, it is difficult for the person whose presence is to be detected to know that he is being observed.

The object to be detected can also be a moving body of any type, e.g. an aircraft taxiing along a runway, a truck or a cable car moving along a taut cable.

CLAIMS

1. A device for detecting the presence of an object, the device, including:

– a light generator disposed at a reference point and capable of emitting an outgoing pulse;

– an optical fibre disposed along a line, in such a way that the weight of the object to be detected when situated near a portion of the fibre causes elastic distortion of the portion, one end of the fibre being placed so as to receive the outgoing pulse from the light generator, the distortion generating a return pulse by partial reflection; and

– a photoelectric receiver disposed near said one end to receive the return pulse; wherein the optical fibre is surrounded by a covering which has a rough inner surface, said distortion being exerted by the rough portions of the inner surface on the outer surface of said portion of the fibre.

2. A device according to claim 1, wherein said line is a railway track on sleepers, said object is a vehicle which travels along the track and the optical fibre is placed under the sleepers.

3. A device according to claim 2, wherein the optical fibre is buried in the ballast of the railway track.

4. A device according to claim 1, wherein said line is disposed across a road, and said object is a vehicle moving along the road.

5. A device according to claim 4, wherein the portion of the optical fibre which crosses the road is buried in the road.

6. A device for detecting the presence of an object, substantially as herein described with reference to and as illustrated in figures 1 to 4 or figures 4 to 5 of the accompanying drawings.

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